INVESTIGATION OF FLY ASH AND ACTIVATED CARBON OBTAINED FROM PULVERIZED COAL BOILERS

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ABSTRACT

OBJECTIVES

One of the techniques for Hg capture in coal-fired boilers involves injection of activated carbon (AC) into the boiler downstream of the air preheater. Hg is adsorbed onto the AC particles and fly ash, which are then both removed in an electrostatic precipitator or baghouse. This project addresses the issues of Hg on activated carbon and on fly ash from a materials re-use point of view. It also addresses the possible connection between SCR reactors, fly ash properties and Hg capture. The project is determining the feasibility of separating AC from fly ash in a fluidized bed and of regenerating the separated AC by heating the AC to elevated temperatures in a fluidized bed. The temperatures needed to drive off the Hg from the ash in a fluidized bed are also being determined. Finally, samples of fly ash from power plants with SCR reactors for NO_x control are being analyzed to determine the effects of SCR on the ash surface chemistry.

ACCOMPLISHMENTS TO DATE

Carbon separation experiments were performed on AC/fly ash mixtures to obtain an expanded range of carbon contents between the top and bottom layers of the fluidized bed. Analyses of both carbon and mercury contents of the samples obtained from these tests show a strong linear relationship between Hg and carbon content, with the Hg content approaching zero as the carbon goes towards zero.

Elevated temperature fluidized bed experiments were performed on the low- carbon content mixture from the bottom layers of the fluidized bed, on the high- carbon content mixture from the top layers of the fluidized bed and on AC/ash mixture with average carbon content. All behaved qualitatively the same way, with a constant Hg content until a critical temperature was reached and then with rapidly decreasing Hg content as the temperature was increased to higher levels. The critical temperature was found to be a linear function of carbon content, increasing from 330°C at 17% LOI to 370°C at 33% LOI. The temperature at which all of the Hg was removed is in the 450 to 500°C range.

Ash and activated carbon samples were evaluated by Light Optical and Scanning Electron Microscopy. SEM studies of the fly ash/AC mixture obtained from the fluidized bed segregation experiments showed marked differences between the materials from the top and bottom layers of the fluidized bed. The top layer is dominated by large, irregularly shaped particles while the bottom layer has more spherical high-mineral content particles. This finding is consistent with the physical mechanism of segregation which results in denser, smaller particles moving downward towards the distributor and lighter, larger particles floating at the top of the bed.

Light Optical Microscopy images of pure activated carbon particles showed them to be irregular in shape and filled with voids. Light Optical Microscopy studies were also performed on a pure fly ash with high carbon content and these showed the naturally occurring carbon in fly ash has an internal structure similar to that of pure activated carbon.

Transmission Electron Microscopy (TEM) and X-Ray Photoelectron Spectroscopy were used in an attempt to detect the presence of Hg on individual activated carbon and fly ash particles. Neither instrument was able to detect Hg on particles in any of the samples, despite the fact that the bulk Hg concentrations ranged up to1000ppm in these samples.

In an effort to determine the effect of SCR on fly ash surface chemistry, TEM and X-Ray Photoelectron Spectroscopy studies were made of samples of fly ash obtained from upstream and downstream of SCR reactors. The 'downstream' SCR material was found to have a significant surface chlorine (Cl) content, while the 'upstream' SCR material was essentially devoid of Cl. In addition, the surface sulfur (s) signal in the 'downstream' sample was found to be about one half of that observed in the 'upstream' SCR sample.

FUTURE WORK

It is planned to analyze samples of activated carbon/fly ash mixtures obtained from Hg capture tests at two additional boilers in the remaining months of the project.

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